imagination to do so, that the sun was *exactly* in the middle of the *small* circle, and was forced, after repeated observations, to conclude that the sun's centre appeared to be about the ninth part of the distance SR to the west of the true centre S. I can only offer in explanation of this that it was due to some curious, perhaps subjective, effect caused by the part of the arc VYSXW, which was very bright, for *after this ring had vanished* the sun certainly appeared at S, without any alteration that I could see in the position of the two circles left.

There was no trace of any luminosity other than that of the sky at Q. The brightest part of the whole halo, apart from the sun itself and the part of the arc YSX near to the sun, was the arc VRW; but at C, V, Y, X and W, and especially at X and W, the light seemed decidedly brighter than in the other parts of the rings, though there were no proper "mock suns." Since the time when I saw this weird and magnificent display, I have often tried to deduce the observed curves from the known hexagonal forms of ice crystals, and even to produce them empirically by reflecting and refracting light from glass models, but so far without any success. It will be readily seen that the halo bears a certain resemblance to the lunar halo which was the subject of a letter to NATURE of May 1 by Prof. Barnard, but the two are in reality widely different. Probably the form I have just described is of *exceedingly* rare occurrence, for it presents far too grand and curious a spectacle to be visible without exciting attention, and I have never come across any mention or diagram of a halo like it.

T. C. PORTER.

Eton, May 8.

Sun-pillar (?)

MISS HERSCHEL (a careful observer) has just called me out to see one. At 7.10 p.m. she saw the sun above a bank of clouds, in a somewhat hazy sky, but no clouds above it for a space of some 5 degrees. Above that was a light-fringed belt of clouds of great depth. From the sun a parallel-sided pillar of light, just like the reflection of the sun in a slightly rippled sea, stood upright into, and stopped at, the light-fringe; it was not so bright as the reflection spoken of would be, but markedly brighter than the background sky; colour yellow. Miss Herschel had to bicycle home three-quarters of a mile uphill to call me, and it was fading before she reached home.

I was prompt, but too late (7.25) to get a good view. The possibility of Martinique dust induces me to send you this. Sunset moderately red; temperature here 42°; air calm all day; with dark sky and damp mistiness.

W. J. HERSCHEL.

Littlemore, May 13.

Palæolithic Implements in Ipswich.

ALTHOUGH in isolated cases implements of Palæolithic workmanship have occasionally been found in Ipswich, it is only during the last few weeks that a deposit containing abundant Palæolithic remains has been discovered.

On March 21 last, after long searching, I was fortunate enough to hit upon this interesting site, and the result has been a harvest of implements of very varied types. Mr. Clement Reid, whom I acquainted with the discovery, at once came down to examine the spot, and under his guidance it will be carefully studied.

The relations of the deposits remain to be worked out, but so far show some resemblance to those found at Hoxne and Hitchin.

Among the implements found, some have a thick, ochreous patina, while others are almost devoid of it. Most are very slightly rolled, but some are still sharp.

Pointed implements roughly worked at the butt predominate, but in one case the butt-end has been carefully sharpened.

A fine oval implement shows signs of having been worked for hafting, as also does a smaller chisel-like form. Implements corresponding to those described by Sir John Evans as "crescent like," a boring implement, a possible sling-stone, several ovoid forms flat on one side and raised on the other, triangular forms, some thick and heavy, one flat, and a delicate leaf-shaped implement, show the variety of purposes which these flints were made to serve.

The position occupied by the Palæolithic remains appears to be that of a silted-up channel cut through Glacial deposits. Some of the implements were found at a depth of 12½ feet, others considerably higher, which may account for the difference in their condition.

NINA FRANCES LAYARD.

Brückner's Cycle and the Variation of Temperature in Europe.

WE now possess excellent long series of weather-observations for many places. It occurred to me lately to apply to several of the annual temperature series in Europe an averaging process which would tend to bring out the larger waves of variation, or at least to show how year-groups of a given magnitude compare with one another. I have accordingly considered in groups of ten years (1 to 10, 2 to 11, 3 to 12, and so on) the following (see diagram):—A. Annual mean temperature of Greenwich (from 1841). B. That of Geneva (from 1826). C. That of Bremen (from 1829). D. That of Vienna (from 1826).

[The Greenwich curve is drawn on a larger scale than the others. The degrees are Fahr., those of the others Cent. The position of the curves is simply contrived so that they should not cross one another. In the case of Vienna, the continuous curve from 1855 is for the Hohe Warte near Vienna; the previous dotted curve is *approximate* for the same place, deduced from data of the University Observatory in Vienna. The Bremen figures used extend only to 1895, the other series to 1900].

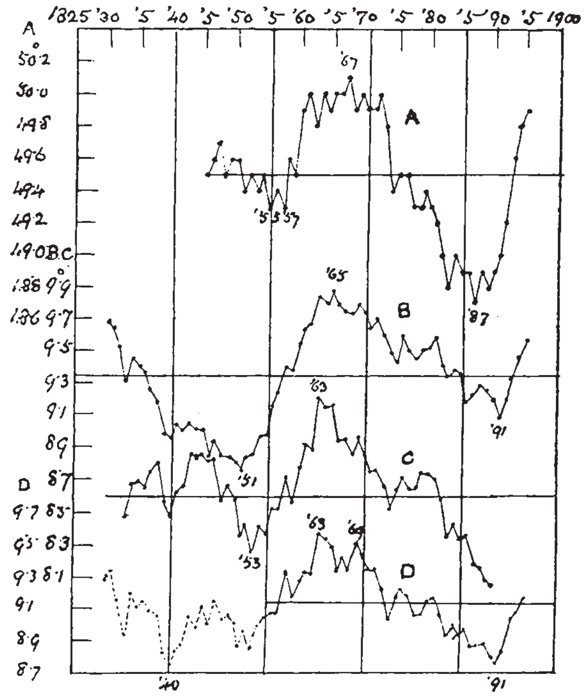

FIG. 1.—A, Greenwich; B, Geneva; C, Bremen; D, Vienna.

Taking the case of Greenwich, it will be understood that the first point, for 1845, indicates the average mean temperature of the ten years 1841 to 1850, the second that of 1842 to 1851, and so on.

The curves, it will be seen, all agree in showing a long wave with crest in the sixties, and extending from a minimum in the fifties (Vienna a little earlier) to another about the end of the eighties (or beginning of nineties).

The Greenwich maximum is reached in 1867, and minima are found at, say, 1855 and 1887. The temperatures prior to 1841 are in some uncertainty; but we should probably be safe in saying that an earlier minimum, of magnitude corresponding rather to the last, occurred about 1816. Thus we have 1816–55 = 39 years; 1855–87 = 32 years; which agrees very fairly with Brückner's cycle of about 35 years. As to previous maxima, we may probably reckon one in the later twenties. The curve (with final point in 1895) would appear to be now near a second maximum from that date (? 1902); and we might with some reason, perhaps, look for another minimum, or conspicuously cold group, in the early twenties of this century.

The minimum of 1855 for Greenwich is considerably less pronounced than that of 1887, and in Bremen, too, the earlier

minimum seems to have been less than the later; while in Geneva the earlier minimum is the deeper.

The facts above given may be usefully compared with Dr. Lockyer's recent important researches, pointing to a cycle of about thirty-five years in the sun-spot variations. It may be doubted if the annual mean temperature of these European stations shows any good evidence of being ruled by the eleven-year cycle of sun-spots; and if it did, the method of smoothing here adopted might even obscure such an effect somewhat. This, however, does not seem to affect the validity of evidence from other orders of data. ALEX. B. MACDOWALL.

Resultant Tones and the Harmonic Series.

IN reply to Prof. Thompson's criticism of the plan of recovering differential resultant tones by means of the harmonic series, may I say that my position is that of a road-maker, not a discoverer—a Macadam rather than a Columbus.

So long as authorities teach that resultant tones have a vibration frequency which is equal to the difference between the vibration frequencies of their generators, so long will the harmonic series afford an easier means to the same end.

This applies also, of course, to summational tones.

The question whether these latter are only "one of the myths of science" or not I leave to abler heads than mine to decide.

Meanwhile, the fact that the perfect fourth, the minor third and the minor sixth give, as the sum of their vibration frequencies, a vibration frequency which is intermediate between two notes, thus exactly agreeing with the harmonic series, $3 + 4 = 7$, $5 + 6 = 11$ and $5 + 8 = 13$, is at least interesting.

MARGARET DICKINS.

Tardebigge Vicarage, Bromsgrove, May 9.

Magic Squares.

HAVING attempted some years ago to determine the number of magic squares of five having a nucleus forming a magic square of three, I was interested to find that further progress towards a solution of the problem has been made by your correspondent Mr. C. Planck, who seems to have found fifty-one solutions more than I from the same twenty-six nuclei, whereas I have only in one case, namely for the nucleus R (5, 7), found one more solution than he. The twenty-one solutions for this nucleus are appended in the following table, from which both the equations and the numbers forming the first row and the first column of the border may be read off without difficulty, if the first dotted number be put at the head of the column, and at the foot of the same the complement of the second. Thus, from the first row of the table,

$$\bar{1} \,.\, \dot{2} \,.\, \dot{4} \,.\, \bar{6} \,.\, \overline{12} \mid \bar{3} \,.\, 8 \,.\, 10$$

we gather that the first row of five minors (numbers less than 13) may be converted into a normal row with sum 5×13 by replacing the three barred numbers by their complements, since $2 + 4 + 13 = 1 + 6 + 12$, whilst the remaining three minors, together with the dotted pair, furnish a normal column when 4 and 3 are replaced by their complements, since here again $4 + 3 + 13 = 2 + 8 + 10$. The border with nucleus, accordingly, when completed, is

	a	b		b'	a'
a	2	25	20	14	4
b	8	11	21	7	18
	10	9	13	17	16
b'	23	19	5	15	3
a'	22	1	6	12	24

1	$\bar{1}$	$\dot{2}$	$\dot{4}$	$\bar{6}$	$\overline{12}$	$\bar{3}$	8	10
2	$\bar{1}$	$\dot{2}$	$\dot{4}$	$\bar{8}$	$\overline{10}$	$\bar{3}$	6	12
3	$\bar{1}$	$\dot{2}$	$\bar{4}$	$\dot{6}$	10	$\bar{3}$	8	12
4	$\dot{2}$	$\bar{3}$	$\bar{4}$	$\dot{6}$	12	$\bar{1}$	8	10
5	$\bar{1}$	$\dot{2}$	$\dot{6}$	$\bar{8}$	$\overline{12}$	$\bar{3}$	4	$\overline{10}$
6	$\dot{2}$	$\bar{3}$	$\dot{6}$	$\bar{8}$	$\overline{10}$	$\bar{1}$	4	$\overline{12}$
7	$\dot{2}$	$\bar{3}$	$\bar{4}$	$\dot{8}$	10	$\bar{1}$	6	$\overline{12}$
8	$\dot{2}$	$\bar{3}$	$\bar{6}$	$\dot{8}$	12	$\bar{1}$	4	$\overline{10}$
9	$\bar{1}$	2	8	$\overline{10}$	$\overline{12}$	3	$\bar{4}$	$\bar{6}$
10	$\dot{2}$	$\bar{3}$	$\bar{4}$	6	$\dot{12}$	$\bar{1}$	8	$\overline{10}$
11	$\dot{2}$	$\bar{3}$	$\bar{8}$	10	$\dot{12}$	$\bar{1}$	4	$\bar{6}$
12	$\bar{1}$	$\dot{4}$	$\dot{6}$	$\bar{8}$	12	2	$\bar{3}$	$\overline{10}$
13	$\bar{3}$	$\dot{4}$	$\dot{6}$	$\bar{8}$	$\overline{12}$	1	$\bar{2}$	$\overline{10}$
14	$\bar{1}$	$\dot{4}$	8	$\overline{10}$	$\dot{12}$	$\bar{2}$	3	$\bar{6}$
15	$\bar{1}$	2	$\bar{4}$	$\dot{6}$	$\dot{10}$	$\bar{3}$	8	12
16	1	$\bar{2}$	$\bar{4}$	$\dot{8}$	$\dot{10}$	$\bar{3}$	6	12
17	$\bar{1}$	2	$\bar{6}$	$\dot{8}$	$\dot{10}$	$\bar{3}$	4	$\overline{12}$
18	$\bar{2}$	3	$\bar{6}$	$\dot{8}$	$\dot{10}$	$\bar{1}$	4	12
19	$\bar{3}$	4	$\bar{6}$	$\dot{8}$	$\dot{10}$	$\bar{1}$	2	$\overline{12}$
20	1	$\bar{2}$	$\bar{6}$	$\dot{8}$	$\dot{12}$	$\bar{3}$	4	$\overline{10}$
21	3	$\bar{4}$	$\bar{6}$	$\dot{8}$	$\dot{12}$	1	2	$\overline{10}$

When the number 603 is multiplied by 288 we get 173,664 for the number of such nuclear squares. When we proceed to inquire as to the number of all types of magic squares of five, we must begin by doubling the above number, since every magic square with odd root may be varied by permuting the rows above the mid-row, together with the rows below the same, and at the same time the columns on either side of the mid-column, so that the above square may be transformed by reversing the order of the marginal letters a, b and a', b', as follows:—

	b	a		a'	b'
b	11	8	21	18	7
a	25	2	20	4	14
	9	10	13	16	17
a'	1	22	6	24	12
b'	19	23	5	3	15

If now we add to the number 347,328 thus obtained the squares in which each row and each column contains all the units 1 . 2 . . 5 increased by the four increments 5 . 10 . 15 . 20 without repetitions of either, of which there are at least 21,376, we get 368,704, without considering other types, probably some hundreds of thousands in number, which would certainly bring the minimum to more than half a million.

Shipley, Yorks. J. WILLIS.